

§16. Multiple Eigenmodes of Geodesic Acoustic Mode in Collisionless Plasmas

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Zonal flow (ZFs), which are poloidal $E \times B$ plasma flows due to toroidally and poloidally symmetric ($m=n=0$) potential perturbations, have attracted increasing attention. It is widely accepted that there are two types of ZFs, namely, one is the low/zero frequency branch, the other is higher frequency oscillation, so called the geodesic acoustic mode (GAM). ZFs are believed to be driven by turbulence, and moderate turbulence and turbulent transport. However, both the low frequency ZF and GAM are plasma eigenmodes. Recent progress of the experimental research on GAM has shown that multiple eigenmodes of GAM coexist simultaneously. This encourages the research on various types of branches in the family of ZFS.

In the present work, for simplicity, we consider a simple axisymmetric toroidal system with standard model magnetic

field. An electrostatic potential, which is rigid constant on a magnetic surface, is assumed. This simplification is valid in the case of $T_e \ll T_i$ since the potential variation is related to finite T_e/T_i . Using this model under some assumptions, a series of GAM eigenmodes is studied, which includes the standard GAM, a branch of low frequency mode and a series of Ion Sound Wave (ISW)-like modes. Eigenfrequencies of these modes are obtained analytically from a linear gyrokinetic model in collisionless toroidal plasmas with a constant electrostatic potential around a magnetic surface. The ISW-like mode has a discrete frequency spectrum roughly with a progression of $\sqrt{n\pi}$ times the transit frequency and strongly damped, where n is the natural number. The low frequency eigenmode has a rigid zero frequency for low q but oscillates with a finite frequency of $0.2(v_{ti}/qR)\sqrt{1-1.4/q^2}$ for $q>1.2$, and relaxes on the scaling with the order of transit frequency, v_{ti}/qR . Considering different damping rates of these modes, only a few (the least damped and/or the most excited) modes may play an important role in the turbulence dynamics.

These results will appear in PoP.